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Virtual-based digital library website: A development for the educational technology master's study program at Universitas Negeri Makassar

Andi Achmad Yani*, Hamsu Abdul Gani, Awaluddin Muin, Lu'mu Lu'mu, Arnidah Arnidah, Nurhikmah Nurhikmah

Universitas Negeri Makassar, Indonesia

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Abstract: This research and development study aims to produce a Virtual-based digital library website. The media development process refers to the ADDIE model. The media questionnaire respondents were 10 students (small group trial), 30 (large group trial) and 1 UNM PPs lecturer. The needs analysis was based on interview data with the Head of Study Program and questions on the student questionnaire. The digital library website development design used canva, flowchart, Hypertext Preprocessor (PHP) version 7 and Codeigniter template. The results showed that the assessment of the material expert and media expert validators were each in the valid and very valid categories with an average of 3.8 and 4.5 out of a maximum value of 5. The level of practicality of the media obtained from a small group test of 10 students obtained a percentage of 83.75% (very high) and the results of the analysis of the lecturer response questionnaire obtained an average of 82.50 (very high category). The level of effectiveness of the Virtual-based digital library website media obtained from a large group test with a percentage of 83.46% (very high effectiveness). Based on the results of the analysis, it can be concluded that the development of a virtual-based digital library website in the Master of Educational Technology Study Program, Postgraduate Program, Makassar State University can help manage and become a link for various sources of reference and information.

Keywords: Development, digital library, program, virtual, website

Abstrak: Penelitian research and development ini bertujuan untuk menghasilkan website perpustakaan digital berbasis Virtual. Proses pengembangan media ini mengacu pada model ADDIE. Responden angket media adalah mahasiswa berjumlah 10 (uji coba kelompok kecil), 30 (uji coba kelompok besar) dan dosen PPs UNM berjumlah 1 orang. Analisis kebutuhan didasarkan pada data wawancara dengan Kaprodi dan butir soal pada angket mahasiswa. Desain pengembangan website perpustakaan digital menggunakan canva, flowchart, Hypertext Preprocessor (PHP) versi 7 dan template Codeigniter. Hasil penelitian menunjukkan bahwa penilaian validator ahli materi dan ahli media masing-masing dalam kategori valid dan sangat valid dengan rerata 3.8 dan 4.5 dari nilai maksimal 5. Tingkat kepraktisan media diperoleh dari uji kelompok kecil berjumlah 10 mahasiswa diperoleh persentase 83.75% (sangat tinggi) dan hasil analisis pada angket respon dosen diperoleh rerata 82.50 (kategori sangat tinggi). Tingkat keefektifan media website perpustakaan digital berbasis Virtual yang diperoleh dari uji kelompok besar dengan persentase 83.46% (efektivitas sangat tinggi). Berdasarkan hasil analisis tersebut maka dapat disimpulkan bahwa pengembangan website perpustakaan digital berbasis Virtual di Program Studi Magister Teknologi Pendidikan Program Pascasarjana Universitas Negeri Makassar dapat membantu mengelola, menjadi penghubung berbagai sumber referensi dan informasi.

Kata kunci: Pengembangan, perpustakaan digital, program, virtual, website

*Corresponding author: andiachmadyanii@gmail.com

INTRODUCTION

The development of technology demands everything to be digital, including libraries (Chen & Tsai, 2012). The concept of digitizing libraries has been ongoing for a long time. Efforts to enhance library services have evolved significantly, starting from traditional

manual services in conventional libraries. Over time, these libraries have adopted automated systems, integrating computers into various services (Chandio, 2021; Dar et al., 2017; Ihsan et al., 2024; Kumar & Gopalakrishnan, 2016; Yebowaah & Plockey, 2017). Currently, one innovative solution to address emerging challenges is the establishment of Digital Libraries. Digital Libraries function as a primary alternative to enhance library services by converting collections into electronic or digital formats (Wicaksono, 2021; Winata et al., 2021). These digital collections can then be easily accessed via smartphones and similar devices (Dinesh et al., 2015; Zha et al., 2015).

The digital libraries are a crucial educational innovation capable of supporting and enriching the learning process (Angwaomaodoko, 2023; Arum & Marfianti, 2021; Cassidy et al., 2011; Masrek & Gaskin, 2016). Educational innovation is vital as it drives positive changes in teaching and learning methodologies, adapting to rapid advancements in technology and information (Dainamang et al., 2024; Nwafor et al., 2022). The creation of a virtual-based digital library website also aligns with the vision and mission of Universitas Negeri Makassar to become a leading center of innovative education with global competitiveness. As one of the leading universities in Indonesia, Universitas Negeri Makassar is committed to continuous innovation in providing quality education services relevant to societal needs and the job market. With a modern and comprehensive digital library, the university can better meet student demands, enhance academic productivity, and strengthen its image as a progressive educational institution focused on the future.

This research focuses on the development, use, utilization, practicality, and effectiveness of digital libraries when tested in formal education settings, particularly in the Master's Program in Educational Technology at Universitas Negeri Makassar (UNM). This serves as empirical groundwork based on data collected through surveys. Many students still face challenges in finding relevant academic references related to educational technology. Based on observational data, 10 Master's students from the Educational Technology Department of UNM in 2022 were sampled to fill out a questionnaire prepared via Google Forms. 70% of students reported moderate difficulty, while 30% found it challenging to locate references within the Educational Technology Department, with 90% agreeing on the need for a specialized information system for the department.

A virtual-based digital library website, as the culmination of its development, can manage and maximize the products and works of UNM's Educational Technology Master's students, serving as a gateway to every reference source. According to legal frameworks such as Law No. 43 of 2007 concerning Libraries and Head of National Library Regulation No. 13 of 2017 concerning National Standards for University Libraries, every university is required to have libraries that meet national standards and comply with National Education Standards. This includes recognizing the need for continuous development within the academic environment. Additionally, Chapter V, Article 14, Paragraph 3 of the law states that libraries must develop their services in line with advancements in information and communication technology.

The researcher asserts that the evolution of library services is a gradual process rather than an instant change. This transformation requires a systematic approach, encompassing not only improvements in library services and infrastructure but also readiness among Master's students in Educational Technology to adopt digitalization. Gradual development must be conducted in stages and cannot be done instantly, with

continuous improvements aimed at overcoming deficiencies, thereby facilitating a smooth transition from conventional libraries to digital libraries

METHOD

This research employs the Research and Development (R&D) approach, with the ADDIE model (Branch, 2009) as the basis for its development process . This model was chosen for its widely recognized systematic approach in instructional design. The product development procedures using the ADDIE model are named according to its five development phases: Analysis, Design, Development, Implementation, and Evaluation, providing a structured method for development.

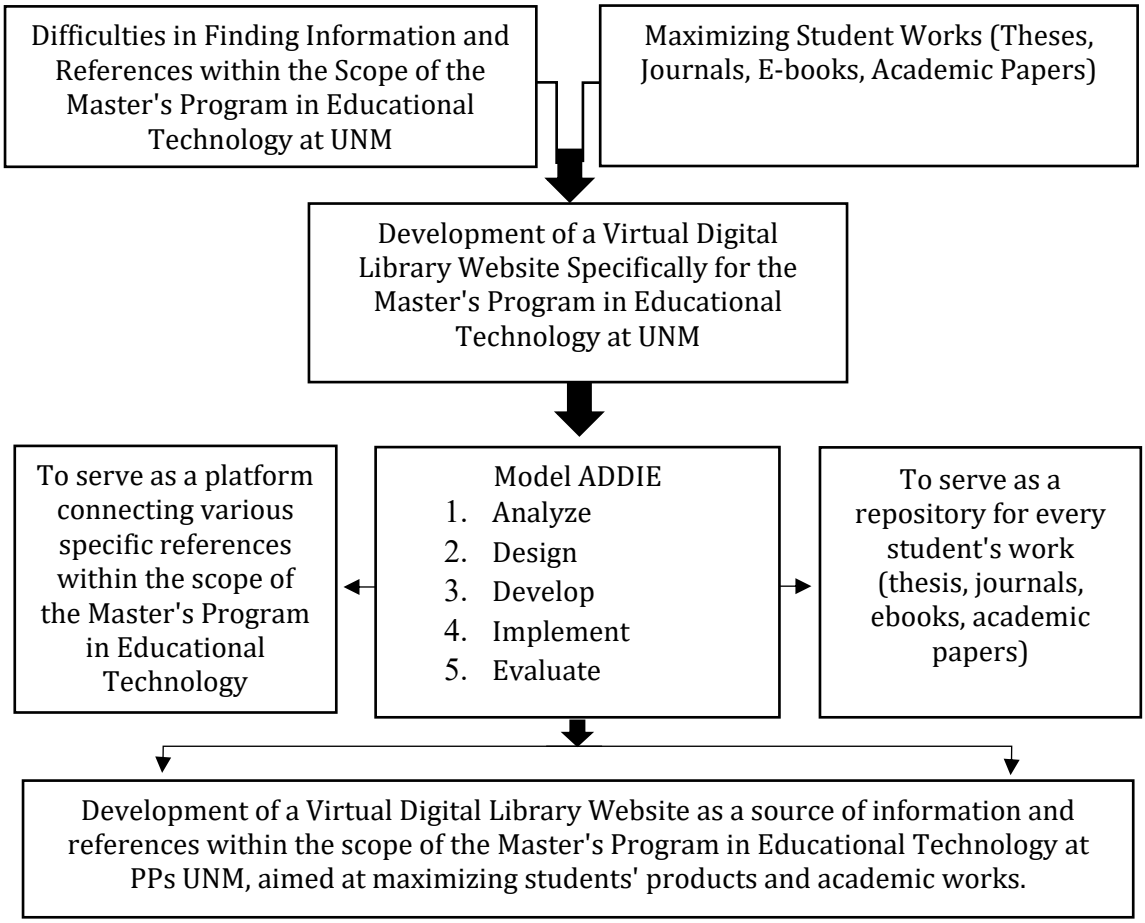

Fig. 1. Virtual-based digital library website development flow

The stages of the ADDIE development model according to Pribadi (2021) is outlined as follows:

1. Analyze The first stage in the ADDIE development model is analyze. Researchers conduct a needs analysis through observation instruments and questionnaires among lecturers and Master's students in Educational Technology. This determines the appropriate type of media they require.
2. Design The second stage in the ADDIE model is design. In this phase, the design of a Virtual-based Digital Library Website involves several key components: a) software design, b) data structure, c) interface representation such as storyboards and

prototypes, and d) algorithms. The goal of this design phase is to ensure that the developed media meets the needs of the users, in this case, the students of the Educational Technology Master's Program.

3. Development The third stage in the ADDIE model is development. In this phase, the Virtual-based Digital Library Website is created using XAMPP software. After the media is developed into a finished product, it undergoes review by the supervising lecturer before validation by media, design, and content experts. A small group trial of ten students and one faculty member was conducted to assess practicality.
4. Implementation The fourth stage in the ADDIE model is implementation. Once content and media experts deem the Digital Library media suitable, the next step is to pilot it with 30 students and lecturers of the Educational Technology Master's Program.
5. Evaluation In the evaluation stage, the media is assessed by users. The evaluation data from the academic community of the Educational Technology Master's Program is analyzed both qualitatively and quantitatively. This analysis aims to determine the suitability of the Digital Library media for the program and to evaluate its practicality and effectiveness.

The research subjects include 30 Master's students of the 2022 cohort in Educational Technology at UNM, 1 media-using lecturer, and 2 expert validators consisting of a media and design validator, and a content and material validator. The sampling technique used for selecting student subjects is Saturation Sampling.

Instruments used include: interview sheets, student observation sheets, expert validation sheets, lecturer response questionnaires, and student response questionnaires. The study utilizes two data analysis techniques: qualitative descriptive analysis and quantitative analysis. Qualitative data is used to assess the extent to which the implementation of the digital library can be applied, obtained through validated questionnaires filled out by students and lecturers. Quantitative analysis involves examining numerical data to understand the needs, validity, practicality, and effectiveness of the digital library. This method focuses on quantitative data analysis presented in numeric form.

$$\text{Average of expert validation} = \frac{\Sigma x}{\text{SMI}} \quad (1)$$

Explanation:
$\sum x$ = Total Score
SMI = Maximum Ideal Score

Table 1. Validity criteria (Wijaya et al., 2021)

Average	Category
4.0 < Average < 5.0	Very Valid
3,0 < Average < 4,0	Valid
2,0 < Average < 3,0	Quite Valid
1,0 < Average < 2,0	Less Valid
0,0 < Average < 1,0	Not Valid

$$\text{Response percentage} = \frac{F}{N}\ x\ 100\% \quad (2)$$

Table 2. Response criteria (Wijaya et al., 2021)

Percentage	Category
< 20%	Very low
21% – 40%	Low
41% – 60%	Moderate
61% – 80%	High
81% – 100%	Very high

RESULTS AND DISCUSSION

The results of the needs analysis stage in this research were obtained from interviews and observations conducted at the Graduate School Campus of Universitas Negeri Makassar (PPs UNM), specifically within the Master's Program in Educational Technology. The needs analysis at PPs UNM involved interviews with the Program Study Head during the preliminary study phase and student observation sheets. Based on the data gathered, the following findings were obtained:

a) There is currently no digital library available in the Master's Program in Educational Technology at PPs UNM.
b) There is a pressing need to initiate digitalization efforts promptly within the Master's Program in Educational Technology at PPs UNM.
c) There is support from the Kaprodi for the development of a digital library in the Master's Program in Educational Technology at PPs UNM.
d) There is a need for a platform to manage the works produced by Master's students in Educational Technology within the department itself.

Table 3. Implementation needs of the digital library

N0	Questions	Description or Notes		
		Yes	Maybe	No
1	Do you often use the internet to search for reference sources?	9	1	-
2	Do you encounter difficulties in finding references, especially within the scope of the Master's Program in Educational Technology at PPs UNM?	7	3	-
3	Have you ever heard of a digital library?	9	1	-
4	A Digital Library is a platform that houses students' works, which can help you find reference sources within the scope of the Master's Program in Educational Technology at PPs UNM. In your opinion, is such a media necessary?	9	1	-
5	If a Digital Library were to be created, do you think it would be effective in the Master's Program in Educational Technology at PPs UNM?	10	-	-
	Total	44	6	0
	Percentage	88%	12%	0%

The researcher also identified the needs of Master's students at PPs UNM in the Educational Technology Department through an identification questionnaire consisting of 5 questions answered by 10 student participants (Table 3). The questionnaire was distributed via Google Forms. The need for a digital library for the Master's Program of Educational Technology is supported by survey results showing that 88% of 10 respondents favor the establishment of a web-based digital library. With this digital library, students can access academic resources quickly and efficiently without time or location constraints, thereby supporting self-learning and in-depth research. Additionally, the digital library facilitates access to relevant journals and e-books in educational technology. This ease of access enhances educational quality and supports the development of knowledge and technological skills among students.

The percentage obtained from the accumulation of all questions indicates that 88% of respondents believe that a digital library is highly needed and worthy of development (Table 3). This data underscores the demand for a product that supports the learning process, especially in terms of accessing educational technology-related reference sources. Needs analysis is carried out to determine user needs, so that the products developed are in accordance with their needs (Damayanti et al., 2024; Karina et al., 2024).

The design stage in the ADDIE model involves designing a digital product that will be developed. This stage is crucial for the development of a website-based digital library capable of managing, facilitating, and maximizing academic works of both Master's students and lecturers in Educational Technology. The media design stage is divided into several steps. In creating the digital library media, the Virtual-based Digital Library website utilizes XAMPP, MySQL, PHP version 7, and the CodeIgniter-3 template. The effective steps involved installing XAMPP to provide a development environment with Apache, MySQL, and PHP. Next, creating a MySQL database to store book, user, and borrowing data. Then, installing CodeIgniter-3 as a PHP framework to facilitate application development using the MVC (Model-View-Controller) pattern. Developing models to manage database interactions, controllers for application logic, and views for a responsive user interface. Finally, testing the application to ensure all features function properly.

Media selection

The media selection is done to identify media that suits the characteristics of the material in order to help achieve learning goals. The media used in the learning process is a website-based media designed using XAMPP, MySQL, and PHP (Hypertext Preprocessor) version 7. PHP is an open-source programming language commonly used to build dynamic and interactive web applications, and in this case, it utilizes the CodeIgniter-3 template. CodeIgniter-3 is a framework developed in 2006 by Rick Ellis, designed for web and application development as an open-source platform (Rahajo, 2018). This framework is created for developers aiming to build websites or applications using PHP programming language. Through CodeIgniter, developers have access to a built-in library containing hundreds of templates and solutions for tasks commonly handled by developers. Additionally, CodeIgniter provides a user-friendly interface (UI) and a simple, logical structure to access these built-in libraries.

Media design

Step 1: Installing XAMPP

Download XAMPP from the official Apache Friends website at https://www.apachefriends.org . Choose the version that matches your Windows operating system. Once the download is complete, open the installation file. Follow the installation instructions by clicking "Next" at each step. During the component selection stage, ensure Apache, MySQL, PHP, and phpMyAdmin are selected for installation directory C:\xampp for Windows. Continue until the installation is complete, and choose to run the XAMPP Control Panel when the installation finishes.

Step 2: Configuring XAMPP Control Panel

Open the XAMPP Control Panel. On Windows, you can find it in the Start menu under the XAMPP folder in Applications.Once the XAMPP Control Panel is open, start the Apache and MySQL modules by clicking the "Start" button next to each module. If successfully started, the status will change to "Running," and a green indicator will appear.

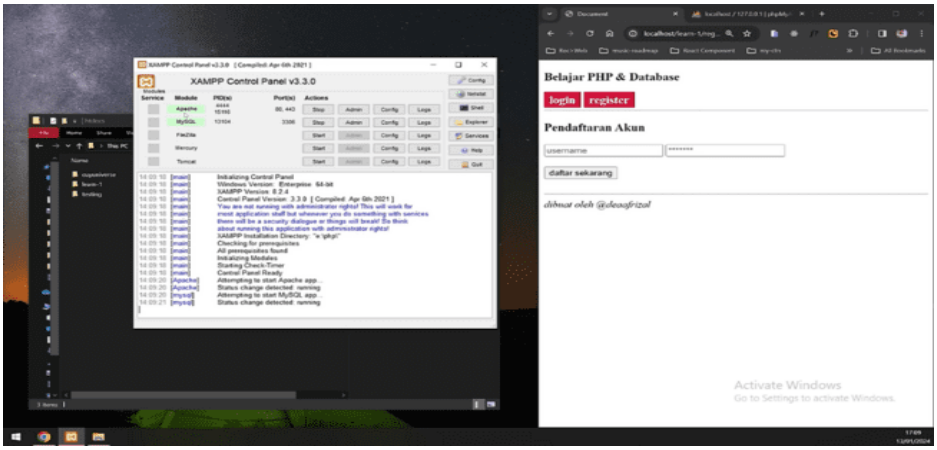

Figure 2 Installing XAMPP and setting up control panel

Step 3: Creating a virtual MySQL

Open a web browser and access phpMyAdmin via http://localhost/phpmyadmin. In php MyAdmin, create a new Virtual by clicking "New" on the left panel, name the database "perpustakaan_digital", and click "Create". Once the database is created, you can add the necessary tables to store data such as books, members, loans, etc.

Step 4: Creating Website File Structure

Create a new folder for the website in the htdocs directory within the XAMPP installation folder, C:\xampp\htdocs\perpustakaan_digital. Within this folder, create the necessary files and folders, such as index.php, style.css, and folders like images, scripts, and includes.

Step 5: Writing PHP Code

Below are steps for writing code in creating a digital library:

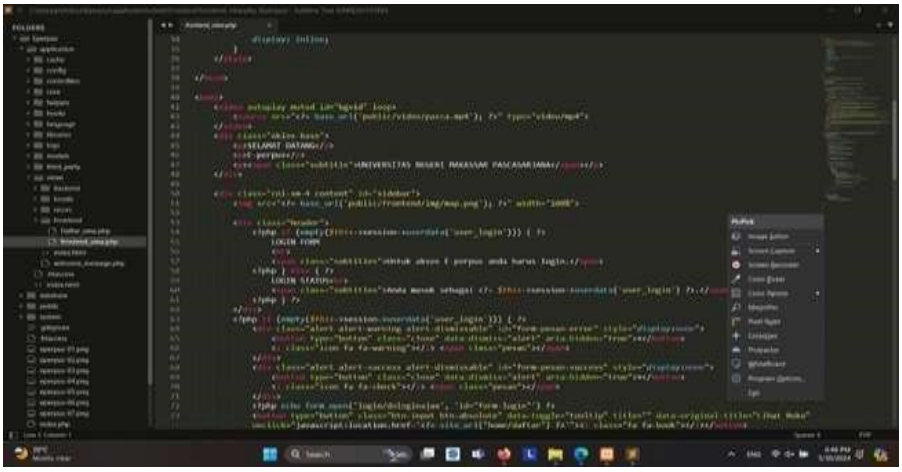

Fig. 3. User interface code

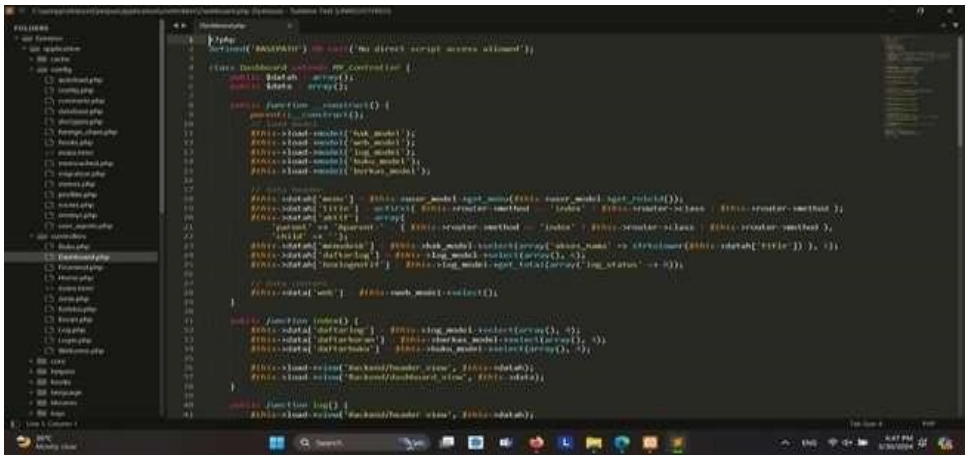

Fig. 4. Dashboard Controller Code

Step 6: Website Design

In writing PHP code using CodeIgniter template as follows:

Fig. 5. CodeIgniter template

Step 7: Creating main functions

Add PHP functions to display data from the database, such as book lists, book details, and search features. Ensure each function calls the appropriate query to retrieve data from the database.

Step 8: Testing

Open a browser and access the website via http://localhost/perpustakaan_digital. Test all features to ensure everything functions properly. If there are errors, check the code and make necessary corrections.

Step 9: Refinement and feature addition

After the website functions well, add additional features as needed, such as a login page and an admin page to manage library data. Continuously test and improve the website quality.

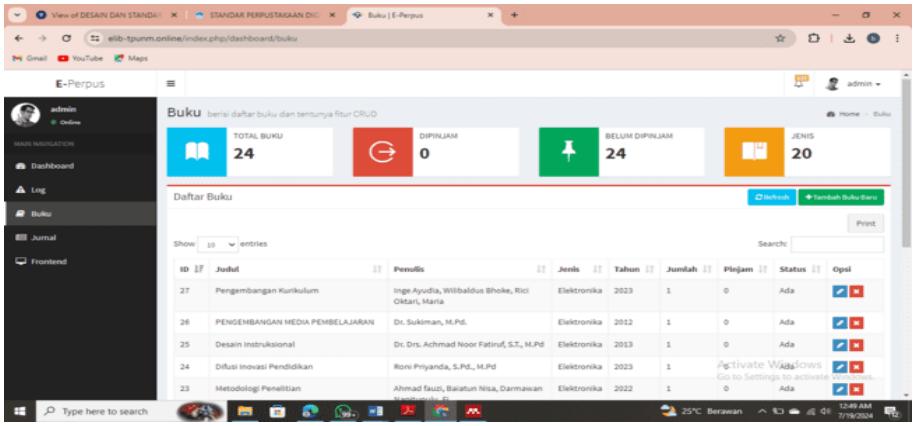

Fig. 6. Dashboard admin website

Creating prototype design

This design results in a prototype of the digital library product to be developed in the development stage as outlined below:

Table 4. Description of initial media design

N0	Components	Description
1	Specifications	This digital library utilizes PHP (Hypertext Preprocessor).
2	Design/template	*CodeIgniter*
3	Visual design	Visual design employs Canva to create attractive designs for users.
4	Framework	• Visitor Page consists of the homepage, login section where users input username and password to access the digital library. • Admin Page includes menus to view login activities, visitor downloads, upload book and journal pages.
5	Content	It includes journals and books uploaded by the admin

Development of web-based digital library

The digital library is developed based on the previous steps. Here are the sections of the developed digital library:

Fig. 7. Login page interface

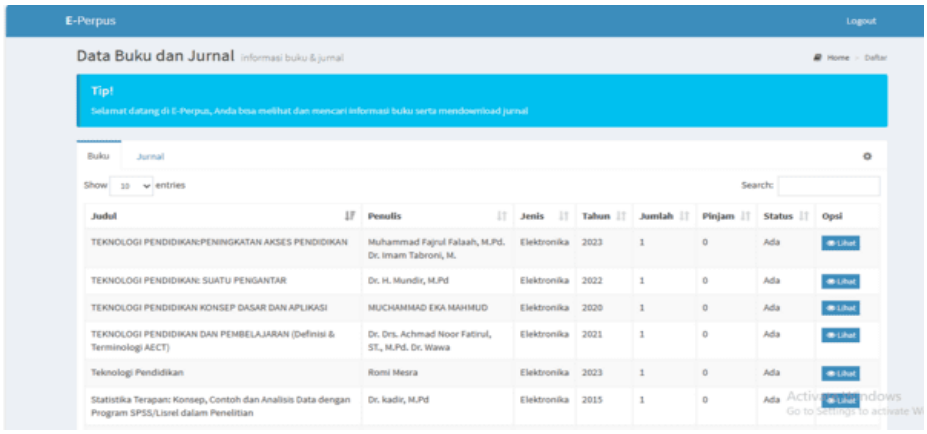

Fig. 8. Visitor page interface

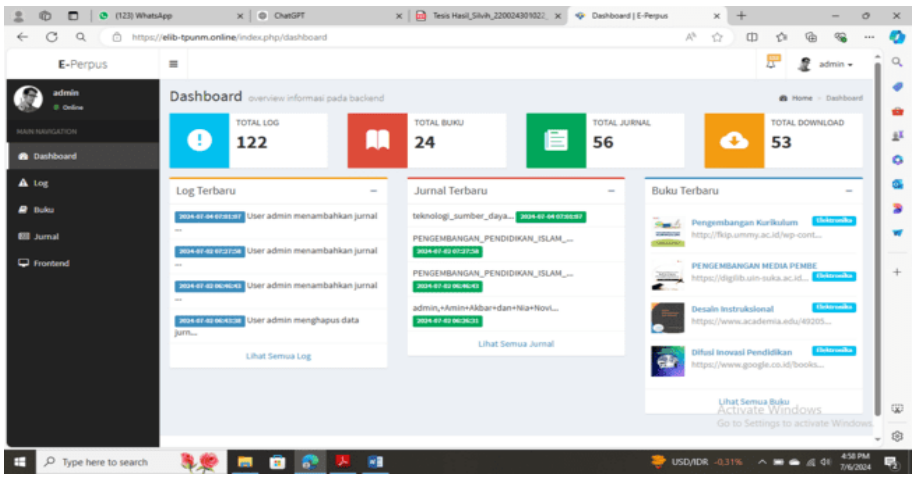

Fig. 9. Admin/manager page

The validation analysis of the digital library in this research was conducted during the development stage according to the ADDIE model. The results of the development stage in this research were conducted by the researcher to obtain a validated product. This validation analysis evaluates how well the information presented meets the needs of students and lecturers.

Validation of the digital library design by a design or media expert is a crucial process to ensure that the digital library adheres to good design principles and meets user needs in this research. The design assessment for the development of the digital library product is conducted by lecturer (doctoral degree) from the Magister of Educational Technology Program at UNM. The Head of the Educational Technology and Vocational Department at the Postgraduate School, Universitas Negeri Makassar, served as the content expert evaluating the developed digital library product.

Table 5. Questionnaire for expert validators of content and materials

No	Aspect Evaluated	Score				
	Content	**1**	**2**	**3**	**4**	**5**
1	Quality of Content in the Digital Library				✓	
2	Adequate Number of Sources				✓	
3	Accuracy of Source Content					✓
4	Relevance of Content to Educational Technology Department					✓
5	The content of the digital library can serve as a valid source of reference.					✓
	Average			4.6		
	Material					
6	Actualization of content				✓	
7	The presented image is clear					✓
8	The text can be read clearly					✓
9	The attractiveness of the content				✓	
10	factualization of content				✓	
	Average			4.4		
	Total Average			4.5		

The digital library research has been validated, based on validation test results by content and material experts indicating that the multimedia meets criteria for content and material, and media and design aspects. Content validation was conducted by Head of the Educational Technology and Vocational Education Department, PPs UNM, with an average validation score of 4.5 out of a maximum of 5, categorized as highly valid. Content experts suggested adding more references, particularly those from the faculty of the Master's Program in Educational Technology, and increasing citations in journals.

Table 6. Questionnaire for expert validators of media and design

No	Aspect Evaluated	Score				
	Media	**1**	**2**	**3**	**4**	**5**
1	Ease of operating the virtual-based digital library website				✓	
2	Accuracy of the layout				✓	
3	Accuracy in design usage				✓	
4	The accuracy of the illustrations used in the display				✓	
5	The suitability of color selection			✓		
	Media Average			**3.8**		
	Design					
6	he quality of images used on the website				✓	
7	Gambar yang disajikan terlihat dengan jelas				✓	
8	The accuracy of icon placement				✓	
9	The quality of the virtual-based digital library website				✓	
10	The attractiveness of the dashboard design			✓		
	Design Average			**3.8**		
	Total Average			**3.8**		

Media and design aspects were validated by a lecturer in the Master's Program of Educational Technology at PPs UNM, with a validation score of 3.8 out of a maximum of 5. Feedback and suggestions from media and design experts included adding usage instructions to facilitate visitor access to the website. Overall, both experts agree that the product is suitable for testing by students and faculty. Products that have met the validity criteria can be tested in small groups (Horota et al., 2023; Nunaki et al., 2019).

The level of practicality in this study was carried out at the trial stage, namely by conducting a trial of the digital library product using small group trials and responses from students and lecturers. This stage involved Educational Technology lecturers who aimed to get feedback on the digital library from lecturers to determine the weight of the practicality of the product being developed.

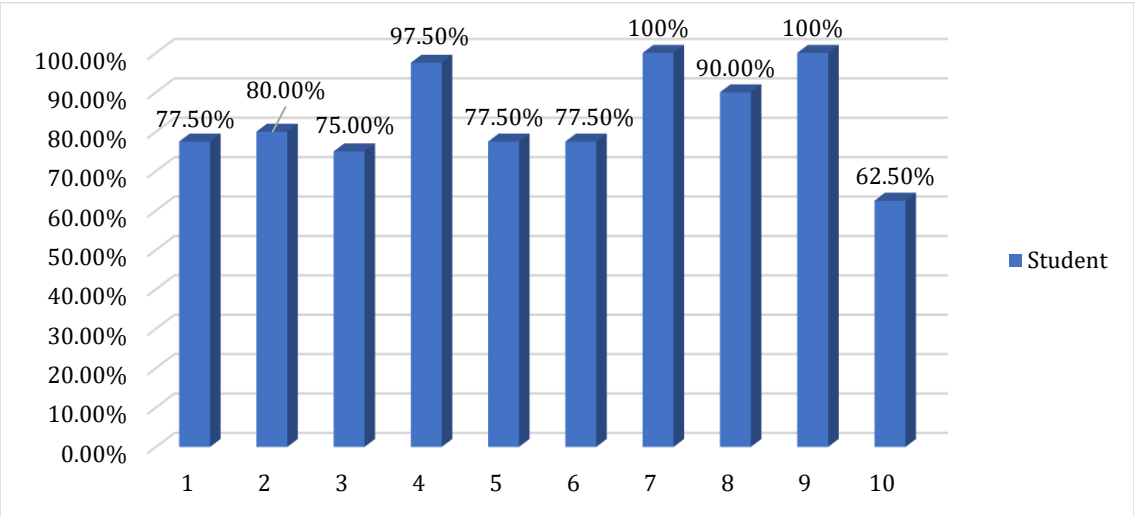

Fig. 10. Student responses to small group trials

The obtained result is 83.75%, categorizing it as very practical. Additional feedback and suggestions from students as users include increasing the variety of references, which the researcher has already addressed by adding more references.

Table 7. Lecturer responses to small group trials

No	Statement	%
Utilization		
1	The website provides easy access to various digital collections such as e-books, journals, and scholarly articles	75.00%
2	The website functions well on various devices, including desktops, tablets, and smartphones.	100%
3	The search function on the website is effective and fast, providing relevant results	75.00%
4	The user interface (UI) design of the website is intuitive and user-friendly, allowing users of various levels of technological proficiency to use it without difficulty	75.00%
5	The website loads pages quickly and responsively, even on slow internet connections	75.00%
	Average	80.00%
Furthermore		
6	The website features are easy to understand	75.00%
7	Users can easily find and access the available resources	75.00%
8	The digital library website enhances interest in searching for information and references	100%
9	The website can serve as a platform to maximize the output of works ranging from journals, theses, to articles	100%
10	The website can be used by anyone needing references by knowing the username and password without any limitations	75.00%
	Average	85.00%
	Total Average	82.50%

Based on the small group trial data, the practicality of the web-based virtual digital library website achieved a percentage of 83.75%, categorized as highly practical. Furthermore, the average response from user faculty members obtained from the survey was 82.50, categorized as highly practical with several previously addressed suggestions. This indicates that the majority of users find the website very user-friendly.

Effectiveness analysis based on the results of a large group questionnaire to students regarding the virtual-based digital library website in the Master's Program in Educational Technology at Universitas Negeri Makassa. Based on the large group trial data, the effectiveness of the web-based virtual digital library website achieved a percentage of 83.46%, categorized as highly effective. This indicates that the majority of users find the website very user-friendly. This percentage reflects that the features provided, such as book and journal searches, and the collection of books and journals, have successfully met user

needs. The website has received positive feedback from users, demonstrating efficiency in supporting student work management activities.

Table 8. Student responses to large group testing

No	Statement	%
1	The digital library in the Master of Educational Technology Department, PPs UNM is easy to access	86.67%
2	The digital library in the Postgraduate Department has provided informative services	84.17%
3	The digital library helps meet your academic needs in terms of research and references	84.17%
4	The digital library of the Master of Educational Technology has good reading quality	80.00%
5	The digital library of the Master of Educational Technology must be implemented in the department because it can help students in finding reference sources	79.17%
6	The digital library has easy-to-understand features	85.00%
7	The management of the digital library is good	81.67%
8	The design of the digital library increases students' interest in finding sources of information/references	85.83%
9	The tools/menus in the digital library are complete	80.00%
10	The digital library in the Master of Educational Technology Department is effectively used in maximizing and managing student work	87.93%
	Average	83.46%

Development of the Virtual-based Digital Library website has completed all procedural stages. The digital library is expected to serve as a connection point for information and reference sources for students, especially in the Master's Program of Educational Technology at PPs UNM. This Virtual-based Digital Library website is also intended to manage and maximize student and faculty works and products. This research is a development study aimed at producing a learning product with valid value impacting practical and effective utilization of students' works in the Master's Program of Educational Technology at PPs UNM.

Following validation by experts, the next step involved involving students and faculty in the implementation (trial) and evaluation phases. The subjects involved 30 students and 1 faculty member for the trial. The evaluation began with briefing students and faculty about the product, allowing them to try it out and complete a media improvement form aimed at assessing whether the digital library is practical and effective for student use. The trial involved two stages: a small group trial by 10 students and 1 faculty member to assess practicality, and a large group trial by all 30 students. The digital library in the Master of Educational Technology Department, PPs UNM is easy to access. Digital libraries make it easier for students to access information wherever they want (Henderson et al., 2017).

The theory put forward by Arum and Marfianti (2021) which states that innovation in the form of a digital library is important because it can support, enrich and encourage positive changes in the learning process. In line with Pribadi (2021) opinion, regarding the constructivist learning theory, the two theories are in accordance with the research results, this is proven in the trial process involving students, they feel interested and show interest and further use of this website (effective) because this website collects many references related to educational technology and their research in it so that users of this website feel practical because they no longer need to open one other person's website because there is a link that leads directly to the original reference. In this search reference, it also supports independent learning in constructivist learning theory because visitors to the site search for the information they need themselves.

In this study, lecturers act as facilitators in utilizing virtual-based digital library websites by promoting digital resources, and integrating their teaching materials into this website. They can also suggest collections to ensure that the content is relevant to the curriculum in the Master's Program of Educational Technology. Meanwhile, students are active in utilizing the website to access learning materials, conduct research, and download necessary references. Digital libraries have provided learning resources that can be accessed and downloaded by users virtually (Mehta & Wang, 2020). They also provide feedback on the functionality and quality of the website content. Collaboration between lecturers and students in maximizing the website has increased the effectiveness and relevance of the digital library in supporting academic and research activities.

CONCLUSION

Based on the research findings and discussions on the development of digital library in the Master's Program of Educational Technology at the Postgraduate Program of Universitas Negeri Makassar, it can be concluded that the developed product is feasible to use. This feasibility is based on the results of validation, trials on students and lecturers.

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